

AMERICAN RIVER –FOLSOM MODIFICATIONS ECONOMIC ANALYSIS

INTRODUCTION

The American River Watershed Project over the last decade has had several reports with a number of features authorized. In this current study of the Folsom Modifications of the project, it is assumed that these features will be completed and be part of the without project condition. The purpose of this analysis is to address economic changes since the 1996 Supplemental Information Report SIR report, define the new without project damages, and estimate benefits of completing the Folsom Modifications.

INVENTORY REVISITED

This section will explain the process used to re-evaluate the structural inventory for the American River Watershed. The original inventory was gathered in 1989-1990 for the 1992 Feasibility Report and then later updated for the 1996 Supplemental Information Report (SIR.) This data was then used as the basis for all damage and benefit estimates found in documents from 1996 (SIR) to the 1999 Section 566 report. In accordance with ER 1105-2-100, those elements that could have the biggest impact on damages and corresponding benefits were given the focus of this reevaluation.

Changes Since 1996 and 1990

Since 1996, there have been several studies¹ performed in the area that indicate that the values and number of residential structures originally computed in the 1990 inventory may have been overestimated. New technologies such as digital databases and GIS were not available in 1989-1990. The residential structure count was based on area averages, developing density (number of units per acre) and using the same relationship throughout the flood plain. Commercial, industrial, and public structures were computed on a structure-by-structure basis and the count did not seem unreasonable. But based on the inconsistencies of residential counts, a 100 % new inventory for residential structures was developed.

Study Area – Economic Reaches

For this re-evaluation, the inventory was grouped geographically into four economic reaches, the Downtown Area, Rancho Cordova, South Sacramento and North Sacramento (for this analysis Natomas reach was excluded as the project does not provide benefits for that area.) The area is extensive, with about 55,000 acres subject to inundation. The reaches and extent of the flood plain can be seen in figure 1.

¹ South Sacramento Streams 1998, Post Flood Assessment 1999, SAFCA Assessment 2000.

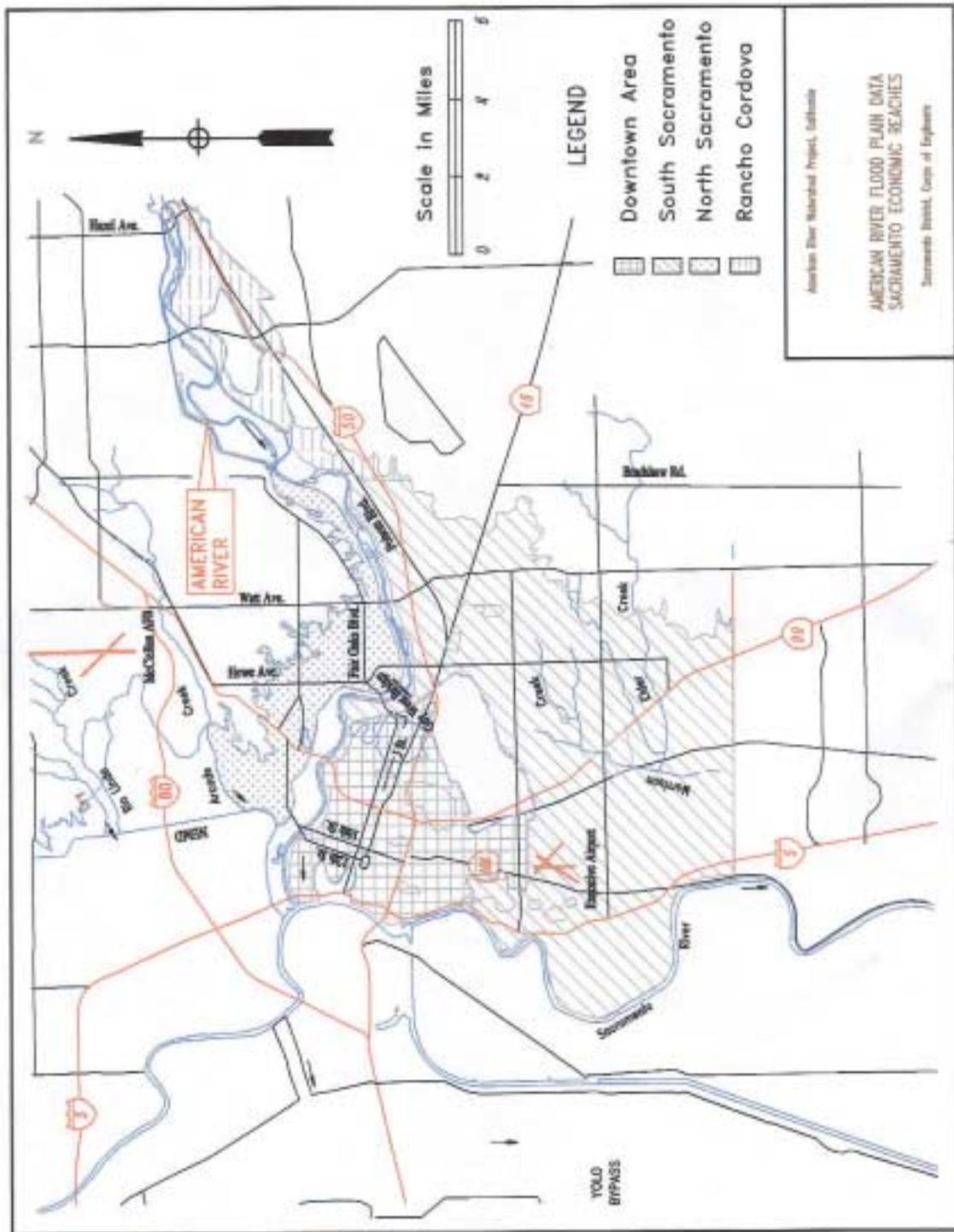


FIGURE 1

Residential Inventory

The original flood plains for this study included 100-year and 400-year frequency delineations. While these frequencies have changed due to new flow-frequency relationships and completed project elements, the corresponding outflows still would produce similar flooding characteristics (same depths, area extent, duration) but at less likely frequencies. The original flood plains were digitized and used for developing the new inventory utilizing digital parcel data. The new inventory represents all residential structures in the flood plain including new development up to November 1999. Table 1 shows the number of residential units by area. The number of residential structures is about 20 % less than listed in earlier inventories.

Commercial- Industrial-Public Inventory

The updated inventory for the 1996 SIR included the original 1989-1990 inventory plus new development up to the end of 1994. This inventory was complete count (without sampling) and is representative of conditions as of 1994. The current study was focused on identifying new structures developed between 1995 and 1999. These new structures were identified by comparing changes in land use from the 1995 and 1999 digital parcel databases. Parcels that were vacant in 1995 but had improvement values in the new database were verified during field visitation and added to the inventory. Additional structures under current construction were also included. The total number of new structures added: 84 commercial, 3 industrial, and 10 public.

**TABLE 1
NUMBER OF STRUCTURES
BY LAND USE AND REACH**

REACH	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	PUBLIC	TOTAL
DOWNTOWN	21,869	1,610	47	383	23,909
NORTH SACRAMENTO	12,046	1,229	29	303	13,607
RANCHO CORDOVA	6,830	262	20	14	7,126
SOUTH SACRAMENTO	64,154	1,528	77	513	66,272
TOTAL	104,899	4,629	173	1,213	110,914

Value of Damageable Property

Values were revised using several methods. All values are listed in October 2000 price levels. All values represent depreciated replacement values.

Residential Structures

Residential values were determined by comparing cost per square foot method with adjusted improvement values. For all residential parcels, the assessed value list was gathered and adjusted based on year of recording assessment. This gave a relative value for each and every structure within the flood plain. To verify the depreciated replacement values, a sample of 365 individual structures were randomly selected. Characteristics, such as square footage, type, class, age and condition were gathered from database, Marshall & Swift Valuation, and field visitation. Value was determined as a function of dollar per square foot (by class & type) multiplied by square footage multiplied by percent of remaining value (total value minus depreciation.) This depreciated replacement value was compared to the adjusted improvement value of the 365 sample structures to determine standard deviation and to verify the values used. The total depreciated replacement value of the sample was only two percent greater than the total adjusted improvement value and this percentage adjustment was made to the remaining residential structures.

Commercial, Industrial, and Public Structures

In contrast to the residential structures (which in the 1990 inventory were based on average values that were aggregated per acre,) the original inventory had unique values for each individual commercial, industrial and public structure. To reevaluate these structures, a sample consisting of more than two hundred structures from the original inventory were selected. From this sample the values used in the 1996 SIR were compared to new values. New values were determined based on square footage, land use, type of activity (retail, office, warehouse, etc.) construction class, and condition. Field visitation was performed and data was gathered for each structure in the sample. Current values were based on cost per square foot method (similar to the method used on the residential but with more class and type distinctions for varying land use activities) and compared to the original values from the 1996 SIR study. Based on the summation of the sample, the new values were 5% less than the old values. As with the residential sample, the data was used in determining standard deviations and the structure values were adjusted to represent the 5% difference in value. New structures were valued at depreciated replacement value and were added to the inventory. The values of these structures are displayed in Table 2

Content Value

Content values were estimated as a percentage of the structure value. The percentages used were the same as used in the original study. For residential structures, a fifty percent content to structure ratio was used. For commercial, industrial, and public the content to structure ratio ranged from 24% to 209% depending the different land uses and activities. For new structures, land use and activity categories were identified and assigned content percentage. The values of contents are displayed in Table 2.

**TABLE 2
VALUE OF DAMAGEABLE PROPERTY
VALUES IN MILLIONS, OCTOBER 2000 PRICES**

LAND USE	AREA REACH				TOTAL
	DOWNTOWN	NORTH SACRAMENTO	RANCHO CORDOVA	SOUTH SACRAMENTO	
RESIDENTIAL					
STRUCTURE	\$ 2,050	\$ 1,605	\$ 945	\$ 5,588	\$ 10,188
CONTENT	\$ 1,025	\$ 802	\$ 473	\$ 2,795	\$ 5,095
COMMERCIAL					
STRUCTURE	\$ 1,440	\$ 1,221	\$ 351	\$ 1,740	\$ 4,752
CONTENT	\$ 1,628	\$ 1,379	\$ 402	\$ 1,980	\$ 5,389
INDUSTRIAL					
STRUCTURE	\$ 23	\$ 14	\$ 25	\$ 154	\$ 216
CONTENT	\$ 25	\$ 14	\$ 27	\$ 160	\$ 226
PUBLIC					
STRUCTURE	\$ 904	\$ 285	\$ 22	\$ 871	\$ 2,082
CONTENT	\$ 377	\$ 121	\$ 17	\$ 456	\$ 971
TOTAL	\$ 7,472	\$ 5,441	\$ 2,262	\$ 13,744	\$ 28,919

FLOOD INUNDATION DAMAGES

Structural and content damages were estimated based on depth of flooding and depreciated replacement value. Depth damage relationships were used to determine the percent of value damaged at a given depth. Depth damage relationships were the same as used in the original study (based primarily on FEMA and TVA curves and verified by other studies.) Uncertainties in structure and content values, first floor elevation, and percent damaged were used in Monte Carlo simulation. These damage relationships (with uncertainty) were estimated for the original non-damaging, the original 100 and 400-year flood plains. The other damage points were interpolated from the original EAD data. Damages to structure and content represent over 95% of the total damages. The other minor damage categories, such as autos, roads and emergency costs, were updated by price indexing and adjusted based on the change in residential structure counts and occupancy.

Stage-Damage Curves

Damages for each category were determined and grouped by the original frequencies used. Damage estimates were then tied to stage (linked by the original flow-frequency relationship) for entry into the MONTE program. The combined stage-damage curve, with uncertainty, is displayed in Table 3. The original stage-damage relationships from the 1992 Feasibility Study reflected zero dollar damages below 43 feet. Since then, a series of levee improvements have brought the zero dollar damage point up to a series of higher stages. This is based on the condition that the levees would not fail below this stage. In the MONTE program, the PNP

(probable non-failure point) determines the stage where damages first occur. With construction completed from the Common Features project, the PNP now equals 49 feet for this study for both with and without project conditions (damages would be zero for all stages below 49 feet.)

**TABLE 3
STAGE-DAMAGE CURVE
Damages in \$ Millions, October 2000 Prices**

Stage in feet	Damage Category					Total Damages	Standard Deviation
	Residential	Commercial	Industrial	Public	Other		
49.33	4,058	1,435	32	585	245	\$ 6,354	\$ 788
55.50	4,769	2,620	133	864	355	\$ 8,741	\$ 952
63.30	5,525	3,253	158	991	457	\$ 10,385	\$ 1,025
67.20	6,255	4,288	195	1,205	627	\$ 12,570	\$ 1,054
68.00	6,365	4,454	199	1,236	627	\$ 12,881	\$ 1,084

Without Project Conditions

Since the original 1992 Feasibility Report, several project features have been either constructed or authorized. In WRDA 1996, two elements (telemetered gages & slurry wall) were authorized followed by a third (levee repairs/Mayhew drain) in WRDA 1999. The without project condition for the Folsom Modification project includes these three elements.

Expected Annual Damages

Annual damages were estimated using the MONTE program. The stage-damage curve listed above was entered along with flow-frequency, inflow-outflow, and stage-flow curves. In addition to these relationships, potential levee failure was estimated based on PNP (probable non-failure points) and PFP (probable failure points) and was incorporated in the program. Project element accomplishments were simulated by changing either the inflow-outflow curve or the PNP/PFP stages. Without project expected annual damages for this study were based on the completion of the Common Features authorized in WRDA's 1996 and 1999. Expected annual damages for these elements are shown in Table 4 below.

TABLE 4
 EXPECTED ANNUAL DAMAGES
 WITHOUT AND PRE-PROJECT CONDITIONS
 DAMAGES IN \$MILLIONS, OCTOBER 2000 PRICES

FEATURE COMPLETED	PROBABLE EXCEEDANCE	EXPECTED ANNUAL DAMAGES
PRE-COMMON FEATURES	0.0120	\$117.93
TELEMETERED GAGES	0.0119	\$116.18
1996 WRDA SLURRY WALL	0.0111	\$111.25
1999 WRDA LEVEE IMPROVEMENTS & WITHOUT FOLSOM MODS	0.0099	\$104.23

BENEFIT ESTIMATION

With Project Damages

Expected annual damages were estimated based on with project conditions. Changes were made to the inflow-outflow relationship to simulate conditions for the Folsom Modification Project. The difference between the without project and with project damages represent the benefits attributable to the project. Benefits were also estimated for Folsom Mods at different levels of surcharge storage. These damages and benefits (in Table 5) represent values based on existing economic conditions.

**TABLE 5
 EXPECTED ANNUAL DAMAGES AND BENEFITS
 WITHOUT AND WITH (EXISTING) CONDITIONS
 DAMAGES IN \$MILLIONS, OCTOBER 2000 PRICES**

FEATURE COMPLETED	PROBABLE EXCEEDANCE	WITHOUT DAMAGES	WITH PROJ RESIDUALS	ANNUAL BENEFITS
NO ACTION	0.0099	\$104.23	\$104.23	\$0.00
FOLSOM MODS @ SURCHARGE TO 470	0.0075	\$104.23	\$80.66	\$23.57
FOLSOM MODS @ SURCHARGE TO 474	0.0070	\$104.23	\$76.02	\$28.21

Risk-Based Results

In addition to expected annual damages, the MONTE program provides data describing project performance and potential risk. The following tables show a comparison of long-term risk, project performance, and probabilistic expected annual damages for both with and without project conditions.

TABLE 6
LONG TERM RISK
THE PROBABILITY OF DAMAGE OCCURING OVER A GIVEN PERIOD

CONDITION	RISK OVER A PERIOD OF TIME		
	10 YEARS	25 YEARS	50 YEARS
Without Project	9%	22%	39%
Folsom Mods (no surcharge above 470)	7%	17%	31%
Folsom Mods with Surcharge to 474	7%	16%	30%

TABLE 7
RELIABILITY -PROJECT PERFORMANCE
PROBABILITY OF NON-FAILURE FROM SPECIFIC EVENTS

CONDITION	PROB OF NON-FAILURE FROM VARIOUS EVENTS			
	50 YEAR	100 YEAR	200 YEAR	400 YEAR
	0.02	0.01	0.005	0.0025
Without Project	93.4%	58.6%	17.4%	2.4%
Folsom Mods (no surcharge above 470)	97.6%	76.7%	34.4%	7.7%
Folsom Mods with Surcharge to 474	98.0%	79.4%	38.2%	9.4%

TABLE 8
 PROBABILITY THAT EXPECTED ANNUAL DAMAGES EXCEED VALUE SHOWN
 VALUES IN \$ MILLIONS, EXISTING CONDITIONS , OCTOBER 2000 PRICES

Condition	Probability That EAD is Exceeded		
	75%	50%	25%
Without Project	\$ 13	\$ 97	\$ 154
Folsom Mods (no surcharge above 470)	\$ 6	\$ 58	\$ 133
Folsom Mods with Surcharge to 474	\$ 6	\$ 12	\$ 131

Future Economic Conditions

In the 1996 SIR, future growth within the flood plain was projected out to the study base year, which was 2008. Excluding Natomas, new damageable structures were limited to the fringe areas to the south and east. In the 1996 study, damages were projected to increase by less than 1.1 percent per year and only for events beyond the 100-year. To verify the growth, damages from structures built from 1995 to 1999 were compared with the total inventory. Based on these findings, damages would not increase due to new growth by more than 0.8 percent per year. The original growth estimates were incorporated with the new growth data to update stage-damage curves (Table 9) up to year 2010. By this date the area within the flood plain should reach full build out. Damages under future conditions were estimated and evaluated over the period of analysis to determine average annual equivalent damages. Average annual equivalent benefits are listed in Table 10, and are based on a 2007 to 2056 period of analysis, October 2000 prices, and 6 3/8 % discount rate.

TABLE 9
 STAGE DAMAGE CURVES FOR LOWER AMERICAN REACHES
 OCTOBER 2000 PRICE LEVELS
 DAMAGES IN \$MILLIONS

STAGE @ INDEX #7	49.33	55.5	63.3	67.2	68 +
2000	\$6,354	\$8,741	\$10,385	\$12,570	\$12,881
2001	\$6,354	\$8,785	\$10,457	\$12,670	\$12,984
2002	\$6,354	\$8,816	\$10,530	\$12,765	\$13,081
2003	\$6,354	\$8,847	\$10,604	\$12,861	\$13,180
2004	\$6,354	\$8,878	\$10,678	\$12,951	\$13,272
2005	\$6,354	\$8,909	\$10,753	\$13,042	\$13,365
2006	\$6,354	\$8,940	\$10,828	\$13,133	\$13,458
2007	\$6,354	\$8,962	\$10,883	\$13,199	\$13,526
2008	\$6,354	\$8,985	\$10,937	\$13,265	\$13,593
2009	\$6,354	\$9,007	\$10,992	\$13,331	\$13,661
2010	\$6,354	\$9,030	\$11,047	\$13,398	\$13,729

**TABLE 10
AVERAGE ANNUAL EQUIVALENT BENEFITS
IN \$ MILLIONS, OCTOBER 2000 PRICES,
6 3/8% INTEREST RATE, 2007 TO 2056 PERIOD OF ANALYSIS**

CONDITION	FUTURE - YEAR 2010		AVERAGE ANNUAL EQUIVALENT DAMAGES WITH PROJECT	AVERAGE ANNUAL EQUIVALENT BENEFITS @ 6 3/8 %
	WITHOUT PROJECT DAMAGES	WITH PROJECT RESIDUALS		
NO ACTION	\$109.92	\$109.92	\$109.75	\$0.00
FOLSOM MODS @ 470 surcharge	\$109.92	\$85.21	\$85.08	\$24.67
FOLSOM MODS @ 474 surcharge	\$109.92	\$80.30	\$80.18	\$29.57

Project Costs-Summary

Detailed explanation of project cost estimates can be found in the engineering appendix. Costs were estimated separately for two project features: 1) Dam Outlets and 2) Surcharge to elevation 474 feet. Interest during construction was estimated based on expenditure start dates for each element, calculated based on mid-year for interest computation up to the base year of 2007. For the outlets, expenditures began in 2000 on Planning Engineering & Design (PED) with construction starting in year 2001. For surcharge, PED is scheduled to begin in 2004 with construction starting in year 2006. All costs were estimated over a 50- year period of economic analysis (2007-2056) using 6 3/8 % interest rate and October 2000 prices.

Benefit Cost Analysis

Benefits and costs were analyzed as two increments. The first, being the completion of the dam outlets, which alone would limit surcharge storage to 470 feet. The second increment, being modifications to the spillway and auxiliary dams, would allow surcharge storage to 474 feet. Table 11 shows the benefits and costs values for these two increments.

Table 11
Benefit Cost Analysis - Folsom Modifications Project
All Values are in \$ Millions

Using October 2000 Prices, 6 3/8 % Interest Rates, 50 year period of economic analysis

	Increment of The Project		Total Project Folsom Modifications
	Outlets	Surcharge	
First Costs	\$ 108.8	\$ 38.6	\$ 147.4
IDC	\$ 29.6	\$ 3.3	\$ 32.9
Investment Costs	\$ 138.4	\$ 41.9	\$ 180.3
Annual Costs			
Interest & Amortization	\$ 9.2	\$ 2.8	\$ 12.0
O&M Cost ¹	\$ -	\$ -	\$ -
Total Annual Costs	\$ 9.2	\$ 2.8	\$ 12.0
Average Annual Benefits			
Existing	\$ 23.6	\$ 4.6	\$ 28.2
Future	\$ 1.1	\$ 0.3	\$ 1.4
Total Annual Benefits	\$ 24.7	\$ 4.9	\$ 29.6
Net Benefits	\$ 15.5	\$ 2.1	\$ 17.6
Benefit-Cost Ratio	2.7	1.8	2.5

1 Note: Operation and Maintenance costs would not increase from current without project estimates